

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization International Bureau



(43) International Publication Date
22 April 2004 (22.04.2004)

PCT

(10) International Publication Number
WO 2004/033078 A1

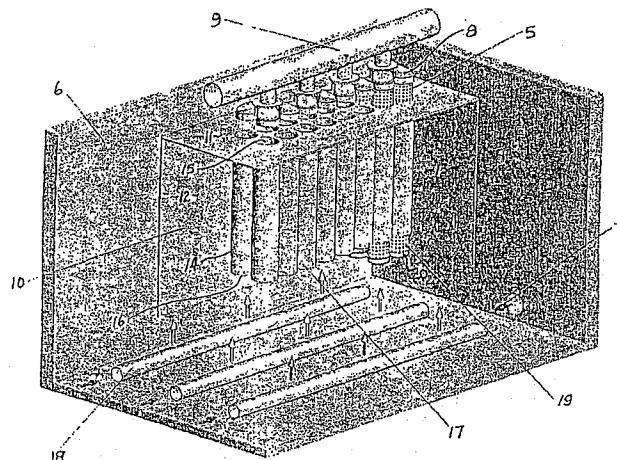
- (51) International Patent Classification⁷: **B01D 65/02, 65/04**
- (21) International Application Number:
PCT/AU2003/001338
- (22) International Filing Date: 10 October 2003 (10.10.2003)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
2002951974 10 October 2002 (10.10.2002) AU
2002952048 11 October 2002 (11.10.2002) AU
- (71) Applicant (*for all designated States except US*): U.S. FILTER WASTEWATER GROUP, INC. [US/US]; 181 Thorn Hill Road, Warrendale, PA 15086 (US).
- (72) Inventor; and
- (75) Inventor/Applicant (*for US only*): JOHNSON, Warren, Thomas [AU/AU]; 125 Grose Vale Road, Grose Vale, NSW 2753 (AU).
- (74) Agent: BALDWIN SHELSTON WATERS; 60 Margaret Street, Sydney, NSW 2000 (AU).
- (81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.
- (84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii)) for the following designations AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN,

[Continued on next page]

(54) Title: BACKWASH METHOD



(57) Abstract: A filtration arrangement including one or more membrane modules (5) positioned vertically within a feed tank (6), each membrane module (5) having one or more membranes positioned therein. An aeration hood (10) having an upper wall (11) and one or more downwardly extending side walls (12, 13) is configured to at least partially shroud the membrane modules (5) within the tank (6). The aeration hood (10) includes a number of open-ended tubes (14), each extending downwardly from the upper wall (11) and forming a respective opening (15) therein. Each tube (14) is adapted to have at least one of the modules (5) mounted therein and extending through the respective openings (15) in the upper wall (11) so as to at least partially surround an outer periphery of an associated module or modules (5). One or more aeration openings (17) are provided in each tube (14) at a location spaced from a proximal end of the tube (16). The aeration hood side wall or walls (12, 13) extend to below the location of the aeration openings (17) in the tubes (14). Gas providing means (18) feed gas into the hood (10).

WO 2004/033078 A1



TR, TT, TZ, UA, UG, UZ, VC, VN, YU, ZA, ZM, ZW, ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG)

— of inventorship (Rule 4.17(iv)) for US only

Published:

— with international search report

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

BACKWASH METHOD

FIELD OF THE INVENTION

The present invention relates to membrane filtration systems, and more particularly to those systems employing porous or permeable membranes located in a tank or cell open to atmosphere and a backwash method and arrangement therefor.

BACKGROUND ART

Any discussion of the prior art throughout the specification should in no way be considered as an admission that such prior art is widely known or forms part of common general knowledge in the field.

Porous membrane filtration systems require regular backwashing of the membranes to maintain filtration efficiency and flux while reducing transmembrane pressure (TMP) which rises as the membrane pores become clogged with impurities. Typically, during the backwash cycle the impurities are forced out of the membrane pores by pressurised gas, liquid or both into the feed tank or cell. Impurities may also be removed from the membrane surfaces by scouring with gas bubbles. The liquid containing impurities and deposits from the membranes is then drained or flushed from the tank.

The waste liquid displaced from the tank needs to be disposed of or reprocessed, usually in an environmentally safe manner, so any reduction in the volume of such waste liquid is seen as advantageous in terms of environmental impact and cost.

- 2 -

- The draining or flushing of the tank, particularly when large arrays of membranes are used also requires time which results in down time of the filtration cycle. In order to reduce this down time large pumping systems are required to quickly drain and refill the tank. Where tanks or cells are arranged in banks and feed is used to refill the tank, a lowering in levels in other cells may be produced during the refill process. This again impinges on operating efficiency of the filtration system.

- Further, in filtration systems employing gas bubble scouring of the membranes it has been found advantageous to confine the bubbles as much as possible in the region of the membranes to assist with the scouring process.

Reduction in backwash volume also reduces the volume of chemical cleaning agents required in some systems. This has the two-fold advantage of reducing cost in terms of chemical requirements while also reducing waste disposal problems.

- Minimising the footprint of filtration systems is also desirable in terms of space eventually occupied by the filtration plant. Compact systems have lesser impact on the environment and are more acceptable to the market.

- The distribution of gas across large membrane module arrays often leads to complex distribution systems and thus it is desirable to reduce the complexity of such systems where possible.

It has been found advantageous to reduce the volume of feed liquid in the filtration cell as well as confine scouring bubbles as much as possible in order to

- 3 -

ameliorate the above problems and provide at least some of the advantages outlined above.

DISCLOSURE OF THE INVENTION

The present invention seeks to overcome one or more of the 5 abovementioned problems of the prior art, provide one or more of the advantages outlined above or at least provide a useful alternative.

According to one aspect, the present invention provides a filtration arrangement including one or more membrane modules positioned vertically within a feed tank, each membrane module having one or more membranes 10 positioned therein, an aeration hood having an upper wall and one or more downwardly extending side walls configured to at least partially shroud said membrane modules within said tank, said aeration hood including a number of open-ended tubes, each extending downwardly from said upper wall and forming a respective opening therein, each tube adapted to have at least one of 15 said modules mounted therein and extending through said respective openings in the upper wall so as to at least partially surround an outer periphery of an associated module or modules, one or more aeration openings being provided in each tube at a location spaced from a proximal end of said tube, said aeration hood side wall or walls extending to below the location of said aeration openings 20 in said tubes, and gas providing means for feeding gas into said hood.

In one preferred form, one or more of said aeration hood side walls are formed by side walls of the feed tank with the upper wall being sealingly attached to the side wall so formed.

- 4 -

For preference, the aeration openings are provided at or adjacent the distal end of each tube and the aeration hood side wall or walls extend to or below the downward extent of a distal end of said tubes.

- Preferably, each membrane module has an associated tube surrounding
- 5 an outer periphery thereof. For preference, the openings comprise a number of through holes located around the periphery of each tube and spaced from the distal end of said tube. In one form, the gas providing means may comprise an aeration header located below the aeration hood.

- In one preferred form, the at least one module includes a sleeve
- 10 surrounding the outer periphery to prevent flow of gas therethrough. The sleeve extends part way along the length of the module to define an open region at or adjacent the lower end of the module to allow flow of gas into the module through said open region, and the hood is positioned to shroud the module at the location of the open region such that gas passing through the aeration
 - 15 openings may pass through the open region into the module membranes.

Desirably openings or an open region are also provided at the top of the module to allow escape of the gas from the module and entry of liquid into the module.

- According to another aspect, the present invention provides a method of
- 20 cleaning membrane modules in arrangement according to the above aspect including the steps of:
 - i) suspending the filtration operation;
 - ii) displacing feed liquid within the aeration hood to a level below the location of said aeration openings in each tube by feeding gas into

- 5 -

- said aeration hood while maintaining a liquid seal with the distal end of each tube;
- iii) passing said gas through said aeration openings into said tubes and along surfaces of membranes within each membrane module to dislodge accumulated fouling materials therefrom;
 - iv) recommencing the filtration operation.

BRIEF DESCRIPTION OF THE DRAWING

A preferred embodiment of the invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 shows a pictorial perspective view of one preferred embodiment of the invention; and

Figure 2 shows a simplified schematic side elevation view of one module of a further embodiment of the invention.

15

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the Figure 1 of the drawings, the arrangement consists of a rack of membrane modules 5 suspended in an open feed tank 6 having a feed inlet 7. The modules 5 are suspended from a group manifold 8 which in turn is connected to main filtrate conduit 9 which extends across the top of the tank 6 and connects to each of the manifolds 8. Located and supported within the tank 6 is a hollow structure forming an aeration hood 10 consisting of an upper wall 11 and side walls 12 and 13. The aeration hood 10 has four side walls (two of which have been cutaway to show the internal configuration of the filter arrangement) and is open at its base. It will be appreciated that the walls of the

- 6 -

hood can be formed by the sides or walls of the feed tank 6 with the upper wall extending between the tank walls and being sealingly attached thereto (not shown). The aeration hood 10 further includes a number of open-ended tubes 14 corresponding to the number of membrane modules 5 which extend 5 downwardly from the upper wall 11 and form openings 15 therein. Each module 5 is accommodated within a corresponding tube 14 which at least partially surrounds the outer periphery of each module 5. Adjacent the distal end 16 of each tube 14 and spaced around the circumference of the tube 14 is a row of aeration holes 17. The size and number of aeration holes will vary with type and 10 size of module and requirements in terms of maintaining a desired pressure drop to ensure a liquid seal with the distal end 16 of the tube 14. Several rows of holes may be provided along the length of the tube 14 at spaced locations, each row having varying sized holes to control the flow of gas. While holes are shown, a variety of openings may be used including slots extending upwardly 15 from the end of the tube 14. The use of slots may provide self-regulation of the desired pressure drop. A series of aeration lines 18 are provided along the bottom 18 of the feed tank 6.

The aeration and cleaning process according to this embodiment may be described as follows. The filtration process is suspended and backwash 20 commenced with backwash gas, typically air, being supplied from aeration lines 18 under the aeration hood 10 so as to bubble up into the void space between the tubes 14. It will be appreciated that gas could also be fed directly into the aeration hood 10 through a pipe or the like. The gas that bubbles up from the aeration lines 18 displaces feed liquid from within the aeration hood 10. The 25 liquid level in the aeration hood 10 drops until it is below the row of aeration

- 7 -

holes 17 near the distal end 16 of the tubes 14. The gas then flows through the holes 17 and into the sides of the module 5 suspended inside the tubes 14. This gas then provides a scrubbing action to scour the membranes within the module 5, whilst the tubes 14 serve to contain the gas within the module 5 thus 5 promoting more effective cleaning.

The distal end 16 of the tube typically extends about 50 to 100mm below the aeration holes 17 in the tube 14, though it will be appreciated that the aeration holes may be located at any desired location along the length of the tube 14 and several rows of holes may be provided. The pressure drop across 10 the aeration holes 17 is selected to ensure that a liquid seal is maintained between the holes 17 and the end 16 of the tubes 14. A gap 19 may also be provided between the end 16 of the tube 14 and the bottom 20 of the module 5 to allow solids to exit from the bottom 20 of the modules.

A further embodiment of hood arrangement is shown in Figure 2. In this 15 embodiment, the membrane module 5 is provided with a sleeve or wrapping 21 along part of its length which assist with retention of aeration gas within the module 5. The sleeve 21 only extends along a part of the module length leaving an open region 22 adjacent the lower end 23 of the module 5. This open region 22 allows flow of feed, backwash and gas to and from the module 5. In this 20 embodiment, the hood 10 is abbreviated in form and shrouds the module 5 at the location of the open region 22 so that the aeration openings 17 are positioned adjacent the open region 22 to allow free movement of aeration gas into the membranes of the module 5. A further open region or aperture (not

- 8 -

shown) is provided at the top of the module 5 to allow the escape of gas and flow of liquid to and from the module.

While the invention has been described in relation in relation to a feed tank open to atmosphere, it will be appreciated that the invention is equally applicable
5 to a closed, pressurized filtration system.

It will be appreciated that further embodiments and exemplifications of the invention are possible without departing from the spirit or scope of the invention described.

CLAIMS:

1. A filtration arrangement including one or more membrane modules positioned vertically within a feed tank, each membrane module having one or more membranes positioned therein, an aeration hood having an upper wall and
5 one or more downwardly extending side walls configured to at least partially shroud said membrane modules within said tank, said aeration hood including a number of open-ended tubes, each extending downwardly from said upper wall and forming a respective opening therein, each tube adapted to have at least one of said modules mounted therein and extending through said respective
10 openings in the upper wall so as to at least partially surround an outer periphery of an associated module or modules, one or more aeration openings being provided in each tube at a location spaced from a proximal end of said tube, said aeration hood side wall or walls extending to below the location of said aeration openings in said tubes, and gas providing means for feeding gas into
15 said hood.
2. A filtration arrangement according to claim 1 wherein one or more of said aeration hood side walls are formed by side walls of the feed tank with the upper wall being sealingly attached to the side wall so formed.
3. A filtration arrangement according to claim 1 or 2 wherein the aeration
20 openings are provided at or adjacent the distal end of each tube and the aeration hood side wall or walls extend to or below the downward extent of a distal end of said tubes.
4. A filtration arrangement according to claim 1, 2 or 3 wherein each membrane module has an associated tube surrounding an outer periphery
25 thereof.

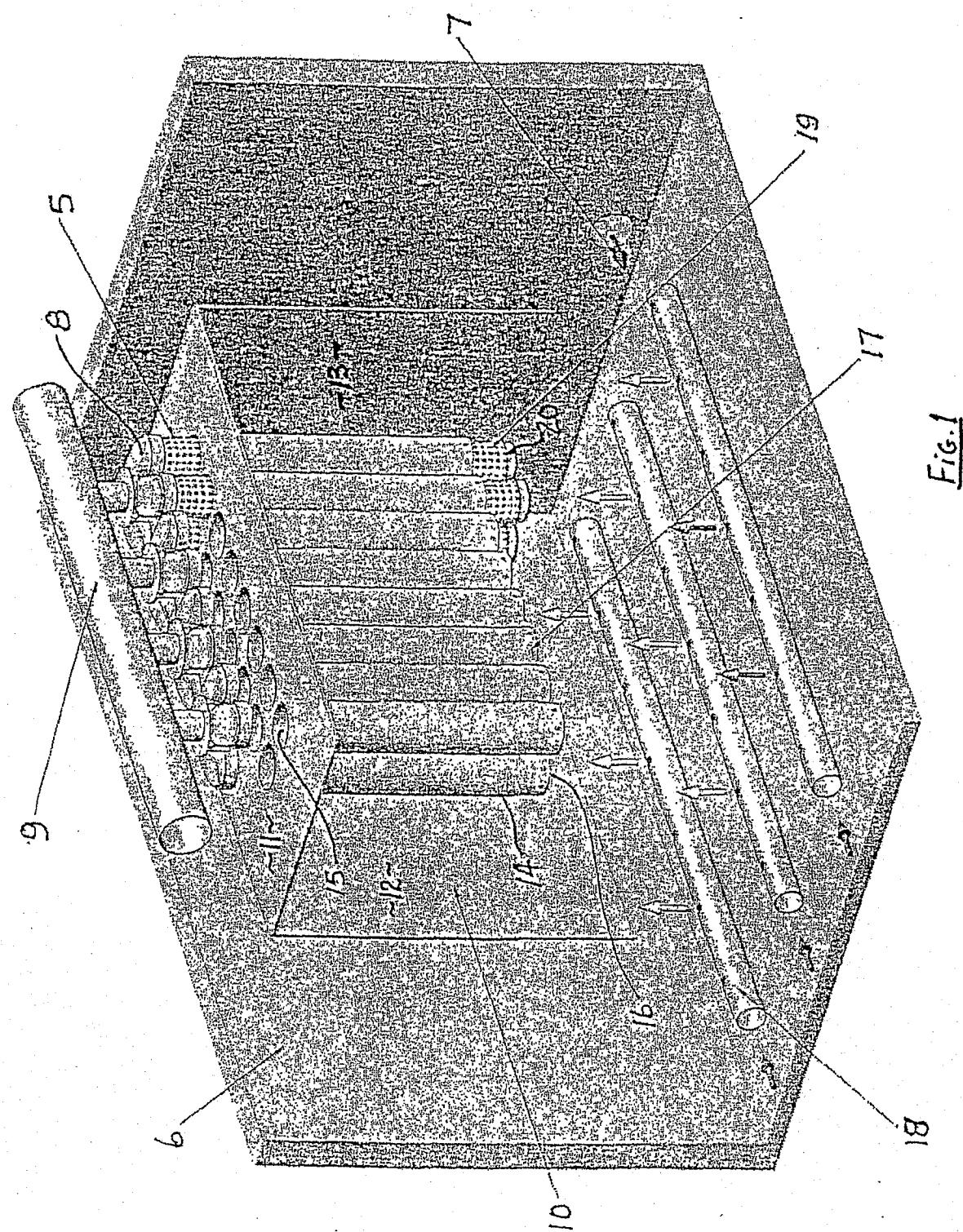
- 10 -

5. A filtration arrangement according to any one of the preceding claims wherein the openings include a number of through holes located around the periphery of each tube and spaced from the distal end of said tube.
6. A filtration arrangement according to any one of claims 1 to 3 wherein the 5 openings include a number of open-ended slots located around the periphery of each tube and extending upwardly from the distal end of said tube.
7. A filtration arrangement according to any one of the preceding claims wherein the gas providing means comprise an aeration header located below the aeration hood.
- 10 8. A filtration arrangement according to any one of the preceding claims wherein said at least one module includes a sleeve surrounding the outer periphery to prevent flow of gas therethrough, said sleeve extending part way along the length of the module to define an open region at or adjacent the lower end of the module to allow flow of gas into the module through said open region, 15 said hood being positioned to shroud the module at the location of said open region such that gas passing through said aeration openings may pass through said open region into the module membranes.
9. A method of cleaning membrane modules in arrangement according to the any one of the preceding claims including the steps of:
 - 20 v) suspending the filtration operation;
 - vi) displacing feed liquid within the aeration hood to a level below the location of said aeration openings in each tube by feeding gas into said aeration hood while maintaining a liquid seal with the distal end of each tube;

- 11 -

- vii) passing said gas through said aeration openings into said tubes and along surfaces of membranes within each membrane module to dislodge accumulated fouling materials therefrom;
- viii) recommencing the filtration operation.

1/2



2/2

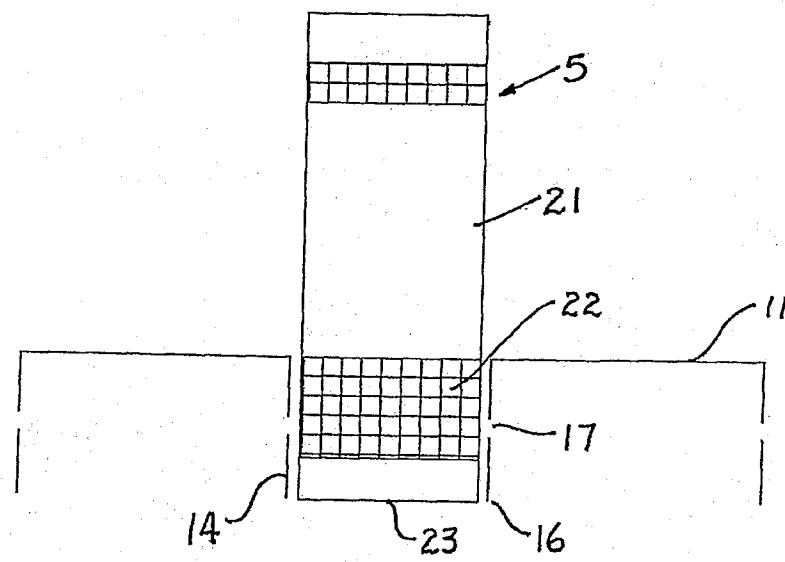


FIG. 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU03/01338

A. CLASSIFICATION OF SUBJECT MATTER		
Int. Cl. ⁷ : B01D 65/02, 65/04		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols)		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) DWPI IPC B01D 65/02, 65/04, B01D, and Keywords (filtration, membrane, vertical, aeration, gas, bubble, scour, scrub, tube, pipe, shroud, concentric, annular) and like terms		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	Derwent Abstract Accession No. 2003376438/36, Class J01 JP 2003047830 A (YUASA CORP KK) 18 February 2003 abstract	1 - 9
A	Derwent Abstract Accession No. 2001351320/37, Class D15 JP 2001104760 A (MITSUBISHI JUKOGYO KK) 17 April 2001 abstract	1 - 9
A	Derwent Abstract Accession No. 98172780/16, Class D15, J01 JP 10033955 A (HITACHI ZOSEN CORP) 10 February 1998 abstract	1 - 9
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C <input checked="" type="checkbox"/> See patent family annex		
<p>* Special categories of cited documents:</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier application or patent but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</p> <p>"&" document member of the same patent family</p>		
Date of the actual completion of the international search 29 October 2003	Date of mailing of the international search report 4 NOV 2003	
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaaustralia.gov.au Facsimile No. (02) 6285 3929	Authorized officer E.J. MARTYN Telephone No : (02) 6283 2332	

INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU03/01338

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	Derwent Abstract Accession No. 99174701/15, Class D15, JP 11028467 A (NKK CORP) 2 February 1999 abstract	1 - 9
A	Derwent Abstract Accession No. 2001194533/20, Class D15, JP 2001009246 A (HITACHI PLANT ENG & CONSTR CO. LTD.) 16 January 2001 abstract	1 - 9
A	Derwent Abstract Accession No. 2001560464/63 Class D15 JP 2001190937 A (SUMITOMO HEAVY IND LTD) 17 July 2001 abstract	1 - 9

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/AU03/01338

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report	Patent Family Member
JP 2003047830	
JP 2001104760	
JP 10033955	
JP 11028467	
JP 2001009246	
JP 2001190937	

END OF ANNEX